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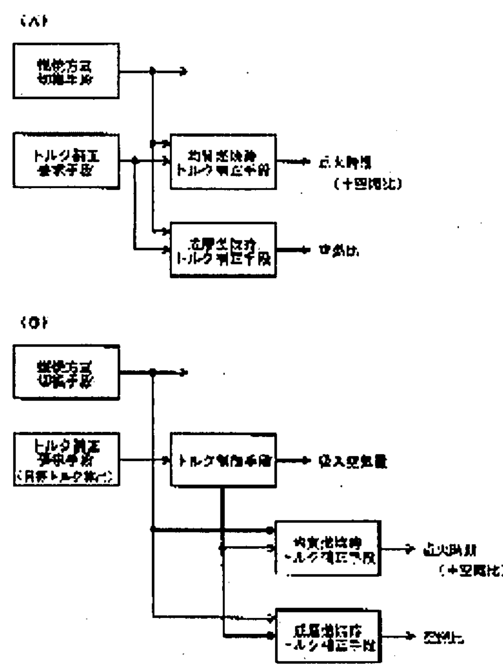
(54) CONTROLLER OF DIRECT INJECTION SPARK IGNITION TYPE ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To establish a proper torque correction when changing-over from the homogeneous combustion to stratified combustion or vice versa is practicable.

SOLUTION: In the case where an engine control device is equipped with a combusting system changeover means capable of changing over between a homogeneous combustion and stratified combustion, a torque correction is made in conformity to a torque correcting request from a torque correction requesting means originating from a shift, air-conditioner being turned on, fuel cut recovery, etc., in such a way through correction of the ignition timing (or ignition timing plus air-fuel ratio) at the time of homogeneous combustion and through correction of the air-fuel ratio at the time of stratified combustion.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the control unit of the direct injection jump-spark-ignition type engine which performs torque amendment based on an engine service condition.
[0002]
[Description of the Prior Art] While carrying out feedback control of the inhalation air content so that it may be completed as target torque by the engine torque in case desired target torque is realized from before at the time of gear change of an automatic transmission etc., there are some which attained target torque amending ignition timing according to the deflection of the engine torque at that time, and target torque, i.e., by performing a torque control (torque amendment) quicker than the responsibility of inhalation air content control by ignition timing amendment, (refer to JP,5-163996,A).
[0003] On the other hand, the direct injection jump-spark-ignition type engine attracts attention in recent years. In this thing According to an engine service condition, a combustion system by injecting a fuel like change-over control, i.e., an inhalation-of-air line It is common to carry out change-over control to the homogeneity combustion performed by making a combustion chamber diffuse a fuel and forming the gaseous mixture of homogeneity, and the stratification combustion performed to the circumference of an ignition plug by forming layer-like gaseous mixture intensively by injecting a fuel in a compression stroke (refer to JP,59-37236,A).
[0004]
[Problem(s) to be Solved by the Invention] However, in such a direct injection jump-spark-ignition type engine, it must light to the timing by which gaseous mixture came near the ignition plug at the time of stratification combustion, and if sufficient torque amendment is difficult since there is little actuation cost of ignition timing if ignition timing tends to be used at the time of stratification combustion and it is going to perform torque amendment at it, and it forces, aggravation of combustion, and when still severer, a flame failure may be produced.
[0005] This invention aims at offering the control unit of the direct injection jump-spark-ignition type engine which can perform torque amendment optimal when switchable for homogeneity combustion and stratification combustion in view of such a trouble.
[0006]
[Means for Solving the Problem] For this reason, it is the direct injection jump-spark-ignition type engine equipped with a switchable combustion-system means for switching for the stratification combustion performed by injecting a fuel in the homogeneity combustion and the compression stroke which are performed by injecting a fuel like an inhalation-of-air line in invention concerning claim 1 as shown in drawing 1 (A). In a thing equipped with a torque amendment demand means to generate a torque amendment demand based on an engine service condition It is characterized by the torque amendment means and forming a torque amendment means in each ** at the time of the stratification combustion which amends an air-fuel ratio at least at the time of stratification combustion, and performs torque amendment to said torque amendment demand at the time of the homogeneity combustion which amends ignition timing at least at the time of homogeneity combustion, and performs torque amendment.
[0007] It is the direct injection jump-spark-ignition type engine equipped with a switchable combustion-system

means for switching for the stratification combustion performed by injecting a fuel in the homogeneity combustion and the compression stroke which are performed by injecting a fuel like an inhalation-of-air line in invention concerning claim 2 as shown in drawing 1 (B). In a thing equipped with a torque amendment demand means to generate a torque amendment demand based on an engine service condition While establishing a torque control means to control an engine inhalation air content and to perform a torque control, to said torque amendment demand, so that torque amendment of a high response to the delay of inhalation air content control may be performed It is characterized by the torque amendment means and forming a torque amendment means in each ** at the time of the stratification combustion which amends an air-fuel ratio at least at the time of stratification combustion, and performs torque amendment at the time of the homogeneity combustion which amends ignition timing at least at the time of homogeneity combustion, and performs torque amendment.
[0008] As invention concerning claim 3 similarly shows to drawing 1 (B), it is the direct injection jump-spark-ignition type engine equipped with a switchable combustion-system means for switching for the stratification combustion performed by injecting a fuel in the homogeneity combustion and the compression stroke which are performed by injecting a fuel like an inhalation-of-air line. In a thing equipped with a target torque calculation means to compute engine target torque based on accelerator opening at least While establishing a torque control means to control an engine inhalation air content and to perform a torque control so that said target torque may be attained, so that torque amendment of a high response to the delay of inhalation air content control may be performed It is characterized by the torque amendment means and forming a torque amendment means in each ** at the time of the stratification combustion which amends an air-fuel ratio at least at the time of stratification combustion, and performs torque amendment at the time of the homogeneity combustion which amends ignition timing at least at the time of homogeneity combustion, and performs torque amendment.
[0009] It is characterized by for said torque control means to consist of invention concerning claim 4 including the need [of computing need basic fuel quantity so that target torque may be realized] basic fuel-quantity calculation means, a target-intake-air-flow calculation means compute target intake air flow from need basic fuel quantity and a target air-fuel ratio, a target throttle opening calculation means compute target throttle opening based on target intake air flow, and the throttle-valve drive control means that drive a throttle valve so that it may become target throttle opening (refer to drawing 7).
[0010] It carries out that it is what a torque amendment means divides the amount of torque amendments into a part for a part for ignition-timing amendment, and air-fuel ratio amendment, amends ignition timing and an air-fuel ratio in invention concerning claim 5 at the time of said homogeneity combustion, performs torque amendment, a torque amendment means considers the amount of torque amendments only as a part for air-fuel ratio amendment at the time of said stratification combustion, amends an air-fuel ratio, and performs torque amendment as the description.
[0011] In invention concerning claim 6, it is characterized by calculating the amount of torque amendments by engine rotation synchronization, and calculating the reflection to the fuel oil consumption of the amount of torque amendments by time amount synchronization in a torque amendment means, at the time of a torque amendment means and stratification combustion at the time of said homogeneity combustion. In invention concerning claim 7, it is characterized by calculating the reflection to the operation of the amount of torque amendments, and the fuel oil consumption of the amount of torque amendments by engine rotation synchronization in a torque amendment means at the time of a torque amendment means and stratification combustion at the time of said homogeneity combustion.
[0012]
[Effect of the Invention] According to invention concerning claim 1, desired torque amendment can be performed irrespective of a combustion system by operating ignition timing at least at the time of homogeneity combustion, operating an air-fuel ratio at least at the time of stratification combustion, and performing torque amendment. According to invention concerning claim 2, to a torque amendment demand, torque amendment of the high speed which cannot be followed can be realized irrespective of a combustion system, and the torque amendment demand can be met by inhalation air content control.
[0013] According to invention concerning claim 3, on the occasion of the torque control to target torque, torque amendment of the high speed which cannot be followed can be realized irrespective of a combustion system, and target torque can be attained by inhalation air content control. According to invention concerning claim 4,

when controlling throttle opening by the so-called torque demand control (control like drawing 7 is called torque demand control), by the inhalation air content control by this, torque amendment of the high speed which cannot be followed can be realized irrespective of a combustion system, and target torque can be attained.
[0014] According to invention concerning claim 5, the possible range of the torque control at the time of homogeneity combustion (dynamic range) can be extended. According to invention concerning claim 6, also in the case of stratification combustion, good responsibility as well as the case of homogeneity combustion can be realized, without making an operation load increase at the time of high rotation. According to invention concerning claim 7, also the case of stratification combustion, and in homogeneity combustion, in all rotational frequencies, equivalent responsibility is completely realizable.
[0015]
[Embodiment of the Invention] The gestalt of operation of this invention is explained below. Drawing 2 is the system chart of the direct injection jump-spark-ignition type engine in which one gestalt of operation is shown. First, this is explained. In the combustion chamber of each gas column of the engine 1 carried in a car, air is inhaled by the inhalation-of-air path 3 in response to control of the ** system throttle valve 4 from an air cleaner 2.
[0016] Opening control of the ** system throttle valve 4 is carried out by the step motor which operates with the signal from a control unit 20. And the electromagnetic fuel injection valve (injector) 5 is formed so that a fuel (gasoline) may be injected directly into a combustion chamber. A fuel injection valve 5 is energized to a solenoid by the injection pulse signal to which an inhalation-of-air line is outputted in a compression stroke from a control unit 20 synchronizing with engine rotation, opens, and injects the fuel whose pressure was regulated by the predetermined pressure. And in compression stroke injection, in injection of an inhalation-of-air line, the injected fuel is spread in a combustion chamber, and homogeneous gaseous mixture is formed, and layer-like gaseous mixture is intensively formed in the circumference of an ignition plug 6, and based on the ignition signal from a control unit 20, it is lit by the ignition plug 6 and burns (homogeneity combustion or stratification combustion). In addition, a combustion system is combination with Air Fuel Ratio Control, and is divided into homogeneity SUTOIKI combustion, homogeneity Lean combustion (air-fuel ratios 20-30), and stratification Lean combustion (about 40 air-fuel ratio).
[0017] The exhaust air from an engine 1 is discharged from a flueway 7, and the catalyst 8 for exhaust air purification is infixed in the flueway 7. A control unit 20 is equipped with the microcomputer constituted including CPU, ROM, RAM, an A/D converter, an input/output interface, etc., and the signal is inputted from various kinds of sensors.
[0018] As said various kinds of sensors, the crank angle sensors 21 and 22 which detect the crankshaft of an engine 1 or cam shaft rotation are formed. These crank angle sensors 21 and 22 output unit pulse signal POS every 1-2 degrees, and can compute an engine speed Ne from the period of the reference pulse signal REF etc. while they will output the reference pulse signal REF for every 720 degrees [/n] crank angle in the crank angle location (predetermined crank angle location in front of the compression top dead center of each gas column) defined beforehand, if the number of gas columns is set to n.
[0019] In addition to this In the throttle-valve 4 upstream of the inhalation-of-air path 3, an intake air flow Qa The air flow meter 23 to detect, the accelerator sensor 24 which detects the accelerator opening (the amount of treading in of an accelerator pedal) ACC, the throttle sensor 25 (the idle switch which serves as ON by the closed position of a throttle valve 4 is included) which detects the opening TVO of a throttle valve 4, O2 which outputs the signal according to Rich Lean of an exhaust air air-fuel ratio in the coolant temperature sensor 26 and flueway 7 which detect the cooling water temperature Tw of an engine 1 The sensor 27, the speed sensor 28 which detects the vehicle speed VSP are formed.
[0020] In here, inputting the signal from said various kinds of sensors, it performs predetermined data processing and a control unit 20 controls the throttle opening by the ** system throttle valve 4, the fuel oil consumption by the fuel injection valve 5, and the ignition timing by the ignition plug 6 by the built-in microcomputer. A flow chart explains the 1st - the 5th example about the control relevant to a torque control (torque amendment) among these control.
[0021] The [1st example] The flow chart of the 1st example is shown in drawing 3 - drawing 5 . Drawing 3 is the amount operation routine of torque amendments, and is performed synchronizing with the reference pulse

signal REF (REF-JOB). In S1, the torque amendment demand (increase and decrease of demand) resulting from gear change, Air-conditioner ON, fuel cut recovery, etc. is read. That is, at the time of gear change, at the time of a torque reduction demand and Air-conditioner ON, at the time of the increment demand in torque, and fuel cut recovery, since a torque reduction demand is generated, this is read by another routine as a torque amendment demand means. In addition, the flow chart of a torque amendment demand (torque amendment demand part operation) routine is shown in drawing 19 - drawing 21 , and it explains to them at the end.
[0022] In S2, it is made to correspond to a torque amendment demand, and the amount PIPER of torque amendments (100**alpha%) is calculated. If radical Motome label torque (driver demand torque) except a part for a torque amendment demand is set to tTe0 (it calculates by another routine) and a part for a torque amendment demand is specifically set to deltatTe, it will calculate by PIPER=[(tTe0+deltatTe) /tTe0] x100(%). Here, amendment nothing and PIPER>100% become the increment demand in torque, and PIPER<100% becomes [PIPER=100%] a torque reduction demand.
[0023] A combustion system is read in S3. Here, a combustion system is switched by referring to a combustion-system change-over map by another routine as a combustion-system means for switching based on engine operation conditions. Namely, the map which defined the combustion system (and radical true quantitative ratio tphi) by making an engine speed Ne and target torque tTe (= tTe0+deltatTe) into a parameter It has more than one according to conditions, such as water temperature Tw and time amount after starting, and a combustion system (and radical true quantitative ratio tphi) is set from the map chosen from these conditions according to the parameter of an actual engine operation condition to either homogeneity SUTOIKI combustion, homogeneity Lean combustion or stratification Lean combustion. Therefore, this is read. In addition, the flow chart of a combustion-system change-over (and radical true quantitative ratio tphi setup) routine is shown in drawing 22 , and it explains to it at the end.
[0024] In S4, homogeneity combustion (homogeneity SUTOIKI combustion or homogeneity Lean combustion) or stratification combustion (stratification Lean combustion) is judged, and it branches according to the result. In homogeneity combustion, it progresses to S5, and the amount PIPER of torque amendments is changed into the amount TQRET of ignition timing amendments using a table as shown in drawing 24 . In tooth-lead-angle amendment, a forward value and in lag amendment, the amount TQRET of ignition timing amendments becomes with a negative value. And the amount PIPER of torque amendments is returned to 100% (with no amendment) by S6, and this routine is ended.
[0025] In stratification combustion, it progresses to S7, it is set to amount TQRET=of ignition timing amendments 0, and ends this routine. In this case, the amount PIPER of torque amendments is maintained by the operation value of S2. Drawing 4 is an ignition timing operation routine, and is performed synchronizing with the reference pulse signal REF (REF-JOB).
[0026] In S11, the fundamental-points fire stage ADVmap currently calculated by another routine is read. In addition, it calculates from the map which set the fundamental-points fire stage ADVmap according to an engine speed Ne and the target torque tTe (or fuel oil consumption Ti) as it was shown in drawing 26 (a) whether the fundamental-points fire stage ADVmap for homogeneity combustion (homogeneity SUTOIKI combustion and homogeneity Lean combustion) is calculated according to MBT control. The fundamental-points fire stage ADVmap for stratification combustion is calculated from the map which set the fundamental-points fire stage ADVmap according to an engine speed Ne and the target torque tTe (or fuel oil consumption Ti) as shown in drawing 26 (b).
[0027] In S12, the amount TQRET of ignition timing amendments is read. In S13, like a degree type, the amount TQRET of ignition timing amendments is added at the fundamental-points fire stage ADVmap, and the final ignition timing ADV is calculated.
ADV=ADVmap+TQRET -- here, since the amount PIPER of torque amendments is changed into the amount TQRET of ignition timing amendments at the time of homogeneity combustion, this is reflected in ignition timing ADV and the torque amendment by ignition timing is made, but since it is amount TQRET=of ignition timing amendments 0 at the time of stratification combustion, do torque amendment by ignition timing -- there is nothing.
[0028] Ignition timing ADV is set to a predetermined register, and it is made to light in the ignition timing ADV S14. Drawing 5 is a fuel-oil-consumption operation routine, and is specifically performed every 10ms the whole

predetermined time (10 second-JOB). In S21, radical true quantitative ratio tphi for Air Fuel Ratio Control set up by another routine is read. Radical true quantitative ratio tphi is set up according to a combustion system. In addition, when equivalent ratio here also calls it a fuel-air-ratio correction factor and an air-fuel ratio is set to AFR, it is expressed with 14.6/AFR.

[0029] The amount PIPER of torque amendments is read in S22. In S23, the amount PIPER of torque amendments is changed into amount of equivalent ratio amendments (multiplier) deltaphi using a table as shown in drawing 25 . Here, since it is amount PIPER=of torque amendments100% at the time of homogeneity combustion, it is set to amount deltaphi=of equivalent ratio amendments 1, and at the time of stratification combustion, since it is amount PIPERof torque amendments =100**alpha%, it is set to amount of equivalent ratio amendments deltaphi=1**beta.

[0030] In S24, like a degree type, radical true quantitative ratio tphi is multiplied by amount of equivalent ratio amendments deltaphi, and the target equivalent ratio tphid is calculated.

In tphid=t phixdeltaphiS 25, like a degree type, the target equivalent ratio tphid etc. amends the basic fuel oil consumption Tp, and the final fuel oil consumption Ti is calculated.

[0031] Ti=TpxtphidxK alpha+Ts -- here, Tp is the basic fuel oil consumption of a SUTOIKI air-fuel ratio, and is calculated by Tp=KxQa/Ne (K is a constant). Kalpha is O2. It is an air-fuel ratio feedback correction factor based on a sensor signal, and is clamped by Kalpha=1 at the time of the Lean combustion.

[0032] Ts is a part for the invalid injection time amendment depending on battery voltage. Thus, the calculated fuel oil consumption Ti is set to a predetermined register, in homogeneity combustion, like the inhalation-of-air line of each gas column, in stratification combustion, the injection pulse signal of the pulse width which is equivalent to this Ti in the compression stroke of each gas column is outputted to each fuel injection valve 5, and fuel injection is made.

[0033] Here, the parts of S1 - S4, and S5, S6, S12 and S13 are equivalent to a torque amendment means at the time of homogeneity combustion, and the parts of S1 - S4, and S7, S22-S25 are equivalent to a torque amendment means at the time of stratification combustion. Drawing 12 shows the example of a response waveform of the 1st example. For example, when it originates in gear change, a torque amendment (torque down) demand is made and it is homogeneity combustion, torque amendment is made by amendment of ignition timing, and torque amendment is made by amendment of equivalent ratio (air-fuel ratio), without amending ignition timing, when it is stratification combustion.

[0034] In addition, the ** system throttle valve 4 is controlled by this example corresponding to the accelerator opening ACC.

The [2nd example] In the 2nd example, drawing 6 performs the amount operation of torque amendments, and drawing 4 and drawing 5 (finishing [explanation]) perform an ignition timing operation and a fuel-oil-consumption operation.

[0035] Drawing 6 is the amount operation routine of torque amendments, and is performed synchronizing with the reference pulse signal REF (REF-JOB). In S31, the target torque on torque demand control (the torque amendment demand resulting from gear change, Air-conditioner ON, fuel cut recovery, etc. is included) is read. The amount of air amendments to target torque is calculated as a torque control means, and this controls the opening of the ** system throttle valve 4 by S32.

[0036] In S33, the output torque at the time of air amendment is presumed. In S34, presumed torque is subtracted from the target torque based on the torque amendment demand on torque demand control, and a part for insufficient torque is calculated. In S35, it is made to correspond to a part for insufficient torque, and the amount PIPER of torque amendments (100**alpha%) is calculated. Here, amendment nothing and PIPER>100% become the increment demand in torque, and PIPER<100% becomes [PIPER=100%] a torque reduction demand.

[0037] A combustion system is read in S36. In S37, homogeneity combustion (homogeneity SUTOIKI combustion or homogeneity Lean combustion) or stratification combustion (stratification Lean combustion) is judged, and it branches according to the result. In homogeneity combustion, it progresses to S38, and it changes the amount PIPER of torque amendments into the amount TQRET of ignition timing amendments. In tooth-lead-angle amendment, a forward value and in lag amendment, the amount TQRET of ignition timing amendments becomes with a negative value. And the amount PIPER of torque amendments is returned to 100%

(with no amendment) by S39, and this routine is ended.

[0038] In stratification combustion, it progresses to S40, it is set to amount TQRET=of ignition timing amendments 0, and ends this routine. In this case, the amount PIPER of torque amendments is maintained by the operation value of S35. A subsequent ignition timing operation routine is made by drawing 4 , and a fuel-oil-consumption operation routine is made by drawing 5 .

[0039] Here, the parts of S33-S37, and S38, S39, S12 and S13 are equivalent to a torque amendment means at the time of homogeneity combustion, and the parts of S33-S37, and S40, S22-S25 are equivalent to a torque amendment means at the time of stratification combustion. The control-block Fig. in the case of performing torque demand control is shown in drawing 7 . It computes target torque tTe=tTe0+deltatTe by the target torque calculation means 101 inputting the accelerator opening ACC and an engine speed Ne, setting up the radical Motome label torque tTe0 with reference to the map which defined beforehand the radical Motome label torque (driver demand torque) tTe0 according to these, and adding torque amendment demand part deltatTe which originates in gear change, Air-conditioner ON, fuel cut recovery, etc. at this.

[0040] The need basic fuel quantity calculation means 102 inputs the target torque tTe and an engine speed Ne, and outputs the need basic fuel quantity tQf with reference to the map which defined the need basic fuel quantity tQf beforehand according to these. When an air-fuel ratio changes a lot, since combustion efficiency differs, the effectiveness amendment means 103 amends the need basic fuel quantity tQf for homogeneity combustion, stratification combustion, etc. according to these. Specifically, the need basic fuel quantity tQf is small amended as an air-fuel ratio becomes Lean. It is because a pumping loss becomes small and effectiveness becomes high as it becomes Lean.

[0041] The target air-fuel ratio calculation means 104 inputs the target torque tTe and an engine speed Ne, and outputs the target air-fuel ratio tAFR with reference to the map which defined the target air-fuel ratio tAFR beforehand according to these. It computes target-intake-air-flow tQcyl =tQfxtAFR by the target-intake-air-flow calculation means 105 consisting of a multiplier, and carrying out the multiplication of the target air-fuel ratio tAFR to the need basic fuel quantity tQf.

[0042] The target throttle opening calculation means 106 is target intake air flow tQcyl. An engine speed Ne is inputted and the target throttle opening tTVO is outputted with reference to the map which defined the target throttle opening tTVO beforehand according to these (tQcyl xNe). The throttle-valve drive control means 107 carries out the step drive of the step motor with the command signal according to the target throttle opening tTVO, and controls a throttle valve 4 to become the target throttle opening tTVO.

[0043] Drawing 13 shows the example of a response waveform of the 2nd example. For example, although air content increase in quantity will be made if it originates in Air-conditioner ON and a torque amendment (torque rise) demand is made, the lack of torque is produced according to the delay of air content control. Then, in homogeneity combustion, torque amendment is made by amendment of equivalent ratio (air-fuel ratio) that a torque insufficiency should be amended, without making torque amendment by amendment of ignition timing, and amending ignition timing, when it is stratification combustion.

[0044] [the 3rd example] -- the 3rd example -- drawing 4 (finishing [explanation]) performs an ignition timing operation, and the amount operation of torque amendments performs a fuel-oil-consumption operation by drawing 9 with drawing 8 . Drawing 8 is the amount operation routine of torque amendments, and is performed synchronizing with the reference pulse signal REF (REF-JOB). in addition -- drawing 8 -- drawing 3 -- S -- one -- ' -- S -- two -- ' -- S -- five -- ' -- S -- six -- ' -- a part -- differing .

[0045] In S1', the torque amendment demand (increase and decrease of demand) resulting from gear change, Air-conditioner ON, fuel cut recovery, etc. is divided into a part for a part for an ignition timing amendment demand (a lit part), and an air-fuel ratio amendment demand (a part for equivalent ratio), and is read separately. Although it is made to correspond to a torque amendment demand and the amount of torque amendments is calculated in S2', based on a part for a part for an ignition timing amendment demand (a lit part), and an air-fuel ratio amendment demand (a part for equivalent ratio), the amount ignition part PIPERAD of torque amendments and the amount equivalent ratio part PIPERMR of torque amendments are calculated, respectively. if a part for deltatTeAD and an air-fuel ratio amendment demand is specifically set to deltatTeMR for a part for an ignition timing amendment demand -- PIPERAD=[(tTe0+deltatTeAD)/tTe0]x -- 100 (%) and PIPERMR=[(tTe0+deltatTeMR)/tTe0]x -- it calculates by 100 (%). Here, amendment nothing and 100% or more become

the increment demand in torque, and 100% or less becomes [100%] a torque reduction demand.
[0046] A combustion system is read in S3. In S4, homogeneity combustion (homogeneity SUTOIKI combustion or homogeneity Lean combustion) or stratification combustion (stratification Lean combustion) is judged, and it branches according to the result. In homogeneity combustion, it progresses to S5', and it changes the amount ignition part PIPERAD of torque amendments into the amount TQRET of ignition timing amendments. In tooth-lead-angle amendment, a forward value and in lag amendment, the amount TQRET of ignition timing amendments becomes with a negative value. And the amount ignition part PIPERAD of torque amendments is returned to 100% (with no amendment) by S6', and this routine is ended.
[0047] In stratification combustion, it progresses to S7, it is set to amount TQRET=of ignition timing amendments 0, and ends this routine. In this case, the amount ignition part PIPERAD of torque amendments is maintained by the operation value in S2'. A subsequent ignition timing operation routine is made by drawing 4 . Drawing 9 is a fuel-oil-consumption operation routine, and is specifically performed every 10ms the whole predetermined time (10 second-JOB). In addition, the parts of drawing 5 and S22' of drawing 9 differ.
[0048] In S21, radical true quantitative ratio tphi for Air Fuel Ratio Control set up by another routine is read. In S22', the amount ignition part PIPERAD of torque amendments and the equivalent ratio part PIPERMR are added like read in and a degree type, and the total amount PIPER of torque amendments is calculated. PIPER=PIPERAD+PIPERMR -100 (%) Here, by making the torque amendment by ignition timing at the time of homogeneity combustion, since it is PIPERAD=100% by the amount ignition of torque amendments, it becomes PIPER=PIPERMR.
[0049] The amount PIPER of torque amendments is changed into amount of equivalent ratio amendments (multiplier) deltaphi in S23. In S24, like a degree type, radical true quantitative ratio tphi is multiplied by amount of equivalent ratio amendments deltaphi, and the target equivalent ratio tphid is calculated.
In tphid=t phixdeltaphiS 25, like a degree type, the target equivalent ratio tphid etc. amends the basic fuel oil consumption Tp, and the final fuel oil consumption Ti is calculated.
[0050] Ti=TpxtphidxK alpha+Ts -- the fuel oil consumption Ti which carried out in this way and was calculated is set to a predetermined register, in homogeneity combustion, like the inhalation-of-air line of each gas column, in stratification combustion, the injection pulse signal of the pulse width which is equivalent to this Ti in the compression stroke of each gas column is outputted to each fuel injection valve 5, and fuel injection is made.
[0051] Drawing 14 shows the example of a response waveform of the 3rd example. For example, when it originates in fuel cut recovery, a torque amendment (torque down) demand is made and it is homogeneity combustion, torque amendment is made by amendment of ignition timing, and amendment of equivalent ratio (air-fuel ratio), and torque amendment is made by big amendment of equivalent ratio (air-fuel ratio), without amending ignition timing, when it is stratification combustion.
[0052] [the 4th example] -- the 4th example -- drawing 4 (finishing [explanation]) performs an ignition timing operation, and the amount operation of torque amendments performs a fuel-oil-consumption operation by drawing 9 (finishing [explanation]) with drawing 10 . Drawing 10 is the amount operation routine of torque amendments, and is performed synchronizing with the reference pulse signal REF (REF-JOB). in addition -- drawing 10 -- drawing 6 -- S -- 35 -- ' -- S -- 38 -- ' -- S -- 39 -- ' -- a part -- differing .
[0053] In S31, the target torque on torque demand control (the torque amendment demand resulting from gear change, Air-conditioner ON, fuel cut recovery, etc. is included) is read. The amount of air amendments to target torque is calculated, and this controls the opening of the ** system throttle valve 4 by S32. In S33, the output torque at the time of air amendment is presumed.
[0054] In S34, presumed torque is subtracted from the target torque based on the torque amendment demand on torque demand control, and a part for insufficient torque is calculated. Although it is made to correspond to a part for insufficient torque and the amount of torque amendments is calculated in S35', the amount of torque amendments is divided into a part for a part for ignition timing amendment (a lit part), and air-fuel ratio amendment (a part for equivalent ratio), and the amount ignition part PIPERAD of torque amendments and the amount equivalent ratio part PIPERMR of torque amendments are calculated. A part for insufficient torque is distributed by the predetermined ratio (table value which switches by the fixed value as which x:1-x ;x were determined beforehand, or the service condition at the time of 0:1 and homogeneity combustion at the time of stratification combustion), and, specifically, the amount ignition part PIPERAD of torque amendments and the

amount equivalent ratio part PIPERMR of torque amendments are calculated. Here, amendment nothing and 100% or more become the increment demand in torque, and 100% or less becomes [100%] a torque reduction demand.
[0055] A combustion system is read in S36. In S37, homogeneity combustion (homogeneity SUTOIKI combustion or homogeneity Lean combustion) or stratification combustion (stratification Lean combustion) is judged, and it branches according to the result. In homogeneity combustion, it progresses to S38', and it changes the amount ignition part PIPERAD of torque amendments into the amount TQRET of ignition timing amendments. In tooth-lead-angle amendment, a forward value and in lag amendment, the amount TQRET of ignition timing amendments becomes with a negative value. And the amount ignition part PIPERAD of torque amendments is returned to 100% (with no amendment) by S39', and this routine is ended.
[0056] In stratification combustion, it progresses to S40, it is set to amount TQRET=of ignition timing amendments 0, and ends this routine. In this case, the amount ignition part PIPERAD of torque amendments is maintained by the operation value in S35'. A subsequent ignition timing operation routine is made by drawing 4 , and a fuel-oil-consumption operation routine is made by drawing 9 .
[0057] Drawing 15 shows the example of a response waveform of the 4th example. For example, although air content loss in quantity will be made if it originates in gear change and a torque amendment (torque down) demand is made, the excess of torque is produced according to the delay of air content control. Then, torque amendment is made by big amendment of equivalent ratio (air-fuel ratio), without making torque amendment by amendment of ignition timing, and amendment of equivalent ratio (air-fuel ratio), and amending ignition timing that this should be amended, when it is stratification combustion.
[0058] The [5th example] In the 5th example, drawing 11 performs the amount operation of torque amendments, and a fuel-oil-consumption operation, and drawing 4 (finishing [explanation]) performs an ignition timing operation. In S1, the torque amendment demand (increase and decrease of demand) resulting from gear change, Air-conditioner ON, fuel cut recovery, etc. is read.
[0059] In S2, it is made to correspond to a torque amendment demand, and the amount PIPER of torque amendments (100**alpha%) is calculated. Here, amendment nothing and PIPER>100% become the increment demand in torque, and PIPER<100% becomes [PIPER=100%] a torque reduction demand. A combustion system is read in S3. In S4, homogeneity combustion (homogeneity SUTOIKI combustion or homogeneity Lean combustion) or stratification combustion (stratification Lean combustion) is judged, and it branches according to the result.
[0060] In homogeneity combustion, it progresses to S41, and it changes the amount PIPER of torque amendments into the amount TQRET of ignition timing amendments. In tooth-lead-angle amendment, a forward value and in lag amendment, the amount TQRET of ignition timing amendments becomes with a negative value. And it is made amount deltaphi=of equivalent ratio amendments 1 (with no amendment) by S42, and progresses to S45-S47. In stratification combustion, it progresses to S43, and it changes the amount PIPER of torque amendments into amount of equivalent ratio amendments deltaphi. And it is made amount TQRET=of ignition timing amendments 0 by S44, and progresses to S45-S47.
[0061] In S45, radical true quantitative ratio tphi for Air Fuel Ratio Control set up by another routine is read. In S46, like a degree type, radical true quantitative ratio tphi is multiplied by amount of equivalent ratio amendments deltaphi, and the target equivalent ratio tphid is calculated.
In tphid=t phixdeltaphiS 47, like a degree type, the target equivalent ratio tphid etc. amends the basic fuel oil consumption Tp, and the final fuel oil consumption Ti is calculated.
[0062] Ti=TpxtphidxK alpha+Ts -- the fuel oil consumption Ti which carried out in this way and was calculated is set to a predetermined register, in homogeneity combustion, like the inhalation-of-air line of each gas column, in stratification combustion, the injection pulse signal of the pulse width which is equivalent to this Ti in the compression stroke of each gas column is outputted to each fuel injection valve 5, and fuel injection is made.
[0063] A subsequent ignition timing operation routine is made by drawing 4 . To the 1st example, this 5th example is what was made to calculate fuel oil consumption by rotation synchronization (REF-JOB) as well as the operation of the amount of torque amendments, and can calculate fuel oil consumption also to the 2nd - the 4th example by rotation synchronization as well as the operation of the amount of torque amendments.
[0064] Next, the difference of the case where fuel oil consumption is calculated by time amount

synchronization (10 second-JOB) like the 1st - the 4th example, and the case where fuel oil consumption is calculated by rotation synchronization (REF-JOB) like the 5th example is described. In the case of a 4-cylinder, by the rotation synchronous (REF-JOB) operation, the period of the reference pulse signal REF for 180 degrees of every crank angles is as follows for every engine speed, for example.
[0065]
1000rpm ... 30ms3000rpm ... It is ... 5000 rpm for 10ms. It is ... 6000 rpm for 6ms. At 5ms, therefore 3000 rpm or more, as compared with 10 second-JOB, it becomes heavy, and by 6000rpm, an operation load turns into a twice as many operation load as 10 second-JOB, and becomes still more remarkable by 6-cylinder and 8 cylinders.
[0066] For this reason, in the 1st - the 4th example, it is made to calculate fuel oil consumption by time amount synchronization (10 second-JOB) for reduction of an operation load. The reason the responsibility at the time of stratification combustion is not spoiled for a time amount synchronous operation, either is as follows. In the low loading (1200 or less rpm extent) of stratification combustion, since 10 second-JOB goes into before fuel injection after calculating the amount of torque amendments by rotation synchronization (REF-JOB), responsibility equivalent to the ignition timing at the time of homogeneity combustion is realizable.
[0067] Also in a case of more than [the above-mentioned rotational frequency], in order to perform reflection to the fuel oil consumption of the amount of torque amendments by time amount synchronization (10 second-JOB), control in every 10ms can be realized and sufficient control is usually performed by the time scale to the torque amendment demand from which a demand is advanced. Furthermore, it explains using drawing 16 and drawing 17 . With reference to drawing 16 , the engine performance is large by whether it is 1 combustion ******, and reflection of the amount of amendments is influenced in a low rotation field, for example, an idle rpm field. The operation of the amount of amendments (TQRET, PIPER) is REF-JOB, and since it is made to ****** to the ignition timing which calculates the amount (TQRET) of amendments by REF, and is set by the REF at the time of homogeneity combustion, the amount of amendments can be made to reflect in the combustion just behind REF here, when reflection to fuel oil consumption is performed by 10 second-JOB. Since 10 second-JOB goes into from REF before a fuel-injection pulse once in this rotation field, the amount of amendments can be made to reflect in the combustion just behind REF like the time of homogeneity combustion after all, although the amount (PIPER) of amendments is calculated by REF at the time of stratification combustion.
[0068] therefore -- low rotation fields, such as an idle rpm field, -- stratification and homogeneity -- in any case, torque amendment is realizable by the equivalent response. Since it is made to ****** to the ignition timing which calculates the amount (TQRET) of amendments by REF, and is set by the REF at the time of homogeneity combustion, the amount of amendments can be made to reflect in the combustion just behind REF, when the operation of the amount of amendments (TQRET, PIPER) is REF-JOB and reflection to fuel oil consumption is performed by 10 second-JOB in a non-idle rpm field (high rotational frequency field) with reference to drawing 17 .
[0069] At the time of stratification combustion, although the amount (PIPER) of amendments is calculated by REF, in this rotation field, also once, 10 second-JOB may not enter and it will be reflected in the 2nd combustion after the amount operation of amendments in this case from REF before a fuel-injection pulse. Therefore, although the timing in which correction value is reflected may be overdue as compared with the case at the time of homogeneity combustion at the time of stratification combustion, according to this operation approach, the operation load in REF-JOB can be reduced and increase of the rotation synchronous operation load at the time of a rotational frequency rise can be prevented.
[0070] Moreover, if the amendment desired value in a non-idle rpm field can respond by time amount synchronization, there are many sufficient things, and since it is not so severe as compared with an idle rpm field, if, as for the demand of reflection timing, correction value is reflected every 10ms, there will be no problem of degradation. therefore -- while preventing increase of a rotation synchronous operation load in a non-idle rpm field -- homogeneity and stratification -- torque amendment is realizable by response sufficient by any case.
[0071] On the other hand, drawing 18 explains the effectiveness in the case of the 5th example. When the capacity of an operation means is high enough, the amount TQRET of amendments and fuel oil consumption Ti

calculate by REF. Amendment of the fuel quantity at the time of stratification combustion can be made to always reflect in the combustion just behind REF like the ignition timing correction value at the time of homogeneity combustion.
[0072] therefore, all rotational frequency fields -- homogeneity and stratification -- torque amendment is realizable by response sufficient by any case. Finally, a torque amendment demand routine and a combustion-system change-over routine are explained. Drawing 19 is the flow chart of the torque amendment demand (torque amendment demand part operation) routine by gear change.
[0073] When it judges whether it is under [gear change] ****** and is under gear change by S201, a gear change pattern is read by S202. And when it judges whether they are those with a torque amendment demand and is by S203, the elapsed time after a torque amendment demand is calculated by S204, and a part for a torque amendment demand is calculated by S205 based on this. Drawing 20 is the flow chart of the torque amendment demand (torque amendment demand part operation) routine by Air-conditioner ON.
[0074] Judging whether it is Air-conditioner ON by S211, in the case of Air-conditioner ON, the elapsed time after ON is calculated by S212, and it calculates a part for a torque amendment demand by S215 based on this. Moreover, in the case of Air-conditioner OFF, the elapsed time after OFF is calculated by S213, it judges whether it is the inside of after [OFF] predetermined time by S214, and, in within after [OFF] predetermined time, a part for a torque amendment demand is calculated by S215 based on the predetermined time after OFF.
[0075] Drawing 21 is the flow chart of the torque amendment demand (torque amendment demand part operation) routine by fuel cut recovery. ****** at the time of fuel cut recovery is judged by S221, and the elapsed time after recovery is calculated by S222 to the case at the time of recovery. And it judges whether it is the inside of after [recovery] predetermined time by S223, and, in within predetermined time, a part for a torque amendment demand is calculated by S224 based on the elapsed time after recovery.
[0076] Drawing 22 is the flow chart of a combustion-system change-over (and radical true quantitative ratio tphi setup) routine. In S301, water temperature, after [starting] time amount, a service condition (an engine speed, target torque), etc. are read as map change-over conditions. In S302, according to map change-over conditions, homogeneity SUTOIKI combustion, homogeneity Lean combustion, and stratification Lean combustion are distinguished, and a map change-over flag (FMAPCH) is calculated.
[0077] It judges whether it is FMAPCH=0, in YES, the map for homogeneity SUTOIKI is referred to by S304 S303, and it is an engine speed Ne (rpm). And target torque tTe (kgm) Radical true quantitative ratio tphi is set up. It is S305 and judges whether it is FMAPCH=1, and in YES, in the case of FMAPCH!=0, it is S306, it refers to the map for homogeneity Lean, and is an engine speed Ne (rpm). And target torque tTe (kgm) Radical true quantitative ratio tphi is set up.
[0078] In the case of FMAPCH!=1, it is S307, it refers to the map for stratification Lean, and is an engine speed Ne (rpm). And target torque tTe (kgm) Radical true quantitative ratio tphi is set up. In addition, an example of the general flow chart of whole control is shown in drawing 23 . The existence of reservation of 10 second-JOB is judged at step a, and, in with reservation, step b-f is performed. That is, a combustion system is switched at step b, a torque amendment demand is detected at step c, the fundamental-points fire stage ADVmap is calculated at step d, radical true quantitative ratio tphi is set up at step e, and fuel oil consumption Ti is calculated at step d.
[0079] On the other hand, when you have no reservation of 10 second-JOB, it is step g, and the existence of reservation of REF-JOB is judged and, in with reservation, steps h and i are performed. That is, the amount PIPER of torque amendments is calculated at step h, and ignition timing ADV is calculated at step i.

[Translation done.]